LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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When Cold Weather Lubrication Becomes Important

COLD weather always introduces a period of headaches to those who have to keep industrial machinery moving regardless of snow and ice. In some instances this will be more difficult than in others, especially where bulk materials must be handled which may have become frozen or snow-covered. The problem of materials handling is at best a severe test upon machinery and lubricants; under adverse conditions where the latter may become so sluggish as to flow with difficulty to the parts to be lubricated, it may become costly due to wear and the necessity for more frequent maintenance.

There is much to be said regarding lubrication of hoisting and materials handling equipment in cold weather for there is a decidedly intimate relationship between lubrication, production and cost of upkeep. In general, the machinery involved is massive, with rugged gears, comparatively heavy duty bearings and wire rope of fairly large dimensions.

The construction of these parts is misleading. For this reason it is difficult for many operators to realize that wear may occur to a serious degree if the proper care is not given to lubrication in cold weather. Wear may also develop to a far greater extent and the results of wear may be far more costly where large contact areas are involved, due to the greater possibility of metallic friction occurring. In other words, as such areas are increased, it will be increasingly difficult to maintain the requisite protective film of lubricant between the moving elements when temperatures are reduced.

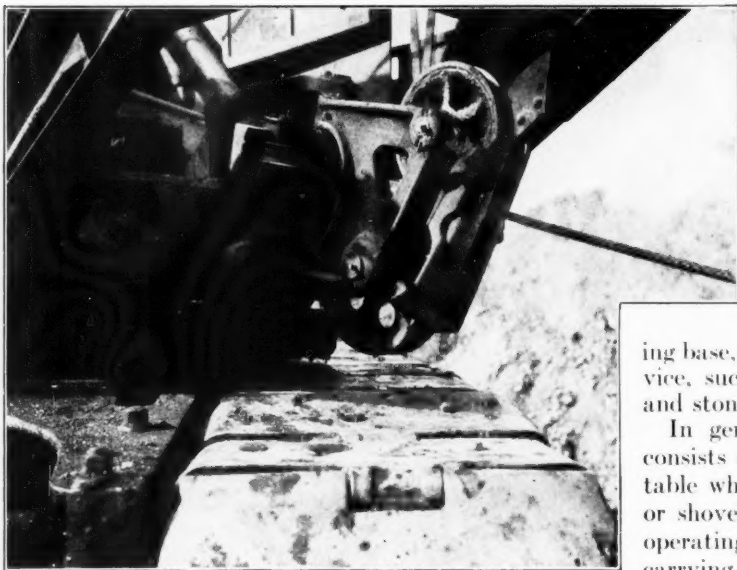
Where operations are carried out under cover with adequate provision for more or less heating, or at least where exposure to weather conditions can be guarded against, lubrication can be more nearly attained. Unfortunately, however, much of this equipment must operate in the open. Frequently, in fact, production requirements will be most severe when operating conditions are the worst, for the output of the plant must not be retarded.

The steel mill is a typical example. With a production schedule laid out, and men and machinery tuned up, to allow storage yard conditions to interfere would be obviously impracticable. So the yard machinery must simply do extra duty, be it in the removal of ice or snow, or floundering through the mud, but always operating nevertheless. The brunt of such service will be borne by the gears, chains, bearings and wire rope, according to the type of equipment involved.

HOW IT IS DONE

Moving of materials in either the raw or finished state, by hoisting or lifting is perhaps one of the most prevalent operations in the average industrial plant. From bulk handling of ore and coke in the steel mill to the storage of case or package goods with a lift truck is a wide range. A variety of equipment is of course involved, of type and construction commensurate with the duty to be performed; the power

shovel, for example, in the handling of coal or coke, the traveling crane for the transference of locomotives or their accessory parts in the locomotive works; the electric hoist for filling coal hoppers in certain boiler plants, and the lift truck for tier storage of barrels in the petroleum industry. To facilitate appreciation of the importance of lubrication, especially where any of the above must operate under abnormally low temperatures or exposed to the rigors of winter weather, it will be advisable to study the basic constructional details of each.



Courtesy of Hazard Wire Rope Co., Inc., and American Chain & Cable Co., Inc.

Fig. 1—The exposure to which wire rope will so often be subjected in heavy duty materials handling machinery operation as indicated above will require that the lubricant be of such a nature as to penetrate as far as possible into the interior of the rope as well as to resist being washed or thrown off from the surface.

The Power Shovel and Drag Scraper

Wherever grab bucket handling of materials such as ore, coal or coke is feasible, the power shovel and drag scraper become most effective pieces of equipment. These materials are subject to outdoor storage, and until actually delivered to blast furnaces, ovens or boilers, must remain in the yards or bins.

Their receiving and handling must, therefore, be studied not only with a view to proper locality in the plant prior to usage, but also relative to proper care of the machinery involved.

This latter is essentially a matter of lubrication. To explain, the majority of the repairs or replacements necessary can be attributed to lack of proper lubrication. There are a number of reasons for this. Such equipment is massive, the wearing elements such as gears, chains, bearings and wire rope are located in more or less inaccessible places, practically all are exposed to the weather, and dust or dirt are always present.

Power shovels are usually built along two designs, according to the class of service they are to be used for. They are customarily known as the revolving and locomotive types. The principles of operation of both are similar, although the former is intended for lighter work, such as would be encountered on building excavations and stripping jobs in mining, etc.; the latter, on the other hand, being equipped with an upper rotating base, is adapted to more severe service, such as in railroad construction and stone quarry service.

In general design a power shovel consists of a revolving frame or turntable which carries the hoisting boom or shovel arm, the engines and other operating mechanisms, and a suitable carrying frame or truck which may be equipped with standard railroad wheels or mounted on a truck fitted with broad traction wheels of the trackless type, or a caterpillar tractor device. In practically every case the machine is self-propelling. The revolving frame is carried on roller bearings or cone rollers which travel on a suitable swinging gear casting securely attached to the truck frame.

The steam power shovel or hoist can be equipped with engines of either the vertical or horizontal type, receiving their steam from a locomotive type or upright boiler located on the turntable. Both engines and boiler are free to swing with the turntable, being mounted on rigid bases and securely bolted to the main revolving casting so that vibration becomes relatively negligible.

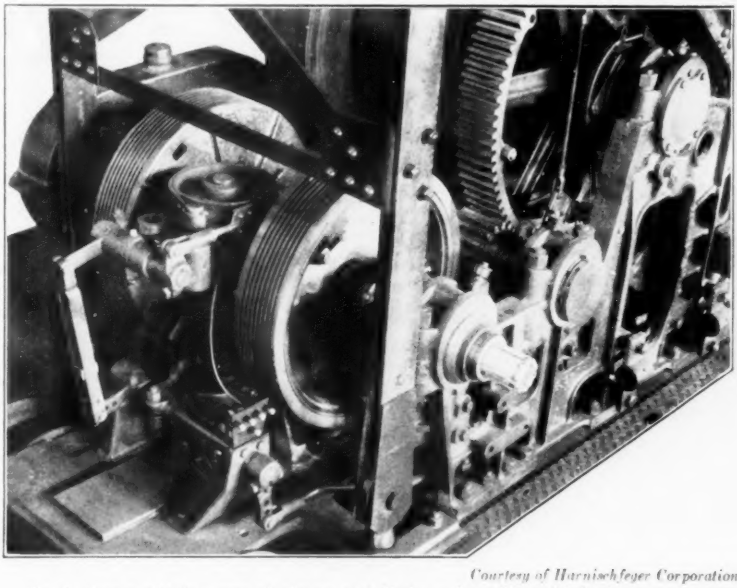
Power shovels are also designed to use the electric motor or internal combustion engine of either the gasoline or Diesel type, thereby replacing steam and the necessity for a boiler.

The number of engines or motors required for the efficient operation of a power shovel, hoist, or drag scraper depend upon the size of the machine. Some smaller machines will have two engines located at right angles to each other, the various crane, shovel and scraper operations being performed by means of clutches. Others will be equipped with only one gasoline or Diesel engine. For larger units, however, separate engines or motors may be

provided to perform the traveling, swinging, hoisting and thrusting operations. Here the hoisting element controls the rise and fall of the shovel or dipper. The swinging engine or motor involves the turntable and the thrusting unit operates the shovel or drag in the process of digging or initial removal of the materials. While many builders install these engines on the turntable itself, some will locate the crowd or thrusting power element on the boom.

The Electric Crane

For straight hoisting work the electric crane is one of the most popular units in any industrial plant. It is flexible, extremely mobile, and capable of handling and locating huge loads with uncanny accuracy. It involves an assemblage of electric motors, bearings, gears and wire ropes. In average service, the principles of operation are essentially the same regardless of whether the jib, gantry, railroad or overhead crane is involved. In brief, the electric motors serve to move the crane proper, to manipulate the trolley along the bridge and to rotate the hoisting drums. The gears serve to bring about the necessary speed reductions. Bearings are, of course, necessary to carry the gear and pinion shafts, trolley wheel journals and motor armatures; and wire ropes or cables are essential for actual hoisting of the grab buckets, or hooks for electromagnets which serve to carry the materials to be handled.



Courtesy of Harnischfeger Corporation

Fig. 2—Gear mechanisms may also be exposed. Under such conditions lubrication must be given quite as much consideration as in the case of wire rope. The average bearing, however, in such a mechanism is more effectively protected and is designed for pressure grease lubrication.

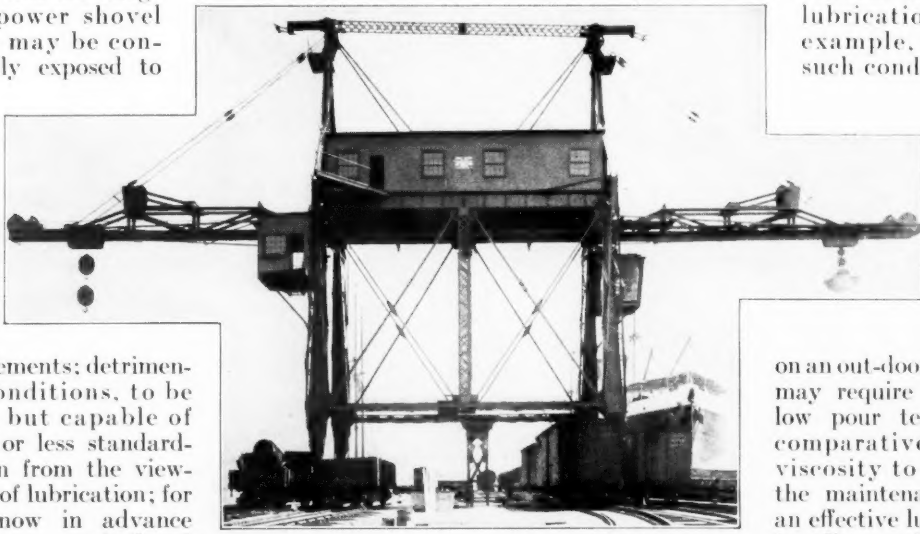
Courtesy of The Osgood Company

Fig. 3—A typical example of power shovel operation showing the nature of the terrain which will sometimes be traversed and the type of materials handled. Obviously, the lubrication of all the working mechanisms of such a shovel must be adequately maintained to prevent deterioration under moisture conditions.

In some one of the above forms the crane is a vital factor in practically every industry where bulky materials or products must be moved with precision, rapidity and expedience. In the iron and steel industry, it is the primary means of moving the product. Visualize the ladle crane for handling molten metals; the ingot stripping crane which removes ingots from their moulds; the ingot charging crane used in connection with the soaking or heating pits; the cranes which charge the open hearth furnaces; and

those which transfer steel plates and shapes from cooling racks to storage and thence to cars or boats for shipping.

In consequence, crane service is perhaps the most varied of any materials handling equipment. The ore bridge and power shovel hoist may be continually exposed to the elements; detrimental conditions, to be true, but capable of more or less standardization from the viewpoint of lubrication; for we know in advance that ice, snow, hail and rain must be encountered; therefore, we select our lubricants accordingly, especially for parts which may not be effectively enclosed.



Courtesy of Link-Belt Company

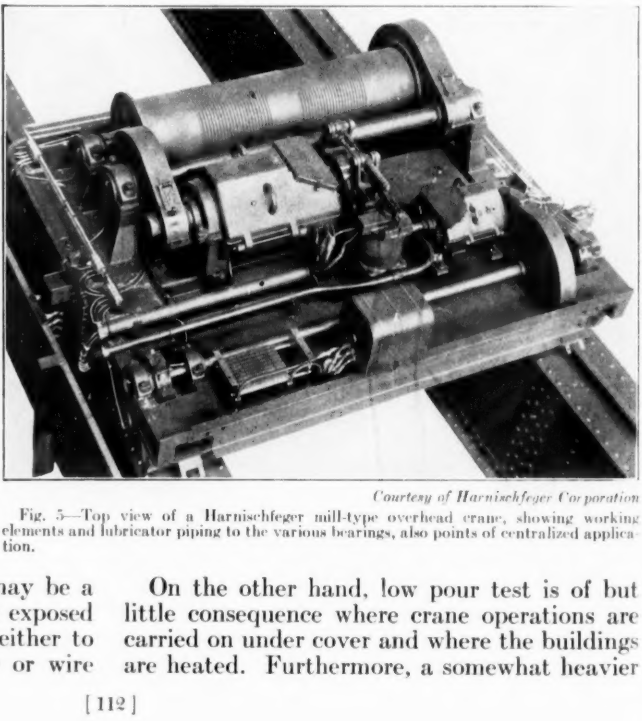
Fig. 4—Freight handling presents another type of operation which may be detrimental to lubrication. In this particular type of hoisting mechanism note extensive use of wire rope and trolley mechanisms.

But electric cranes are different. Where the charging crane in an open hearth or soaking pit building may be subjected to abnormally high radiated heat, the overhead traveling crane in the storage yard may be exposed to the same conditions as the ore bridge.

Yet many operators are prone to regard crane lubrication as likewise capable of standardization. If they find a 1000 seconds Saybolt viscosity (at 210 degrees Fahr.,) gear lubricant suitable to ore bridge gears, on this same premise, a 2000 seconds viscosity lubricant is often regarded as best for all crane gears; the higher average operating temperatures being the basis for this assumption.

Averaging of conditions, however, is not practicable. Too many variables are involved. Where one crane may operate under cover in an atmospheric temperature of 100 degrees Fahr., directly adjacent there may be a similar device in the yard, operating exposed to the weather. It is really fair to neither to attempt to standardize bearing, gear or wire rope lubricants to serve them both. Certain of the wearing elements of one or the other will be bound to suffer.

This is especially true in cold weather when marked temperature differences may be involved. Bearing lubrication, for example, under such conditions, on an out-door crane, may require oils of low pour test and comparatively low viscosity to insure the maintenance of an effective lubricating film, and to reduce the possibility of congealment in the oil reservoirs. Here, an oil of at least zero pour test and approximately 200 seconds Saybolt viscosity at 100 degrees Fahr., would be required.

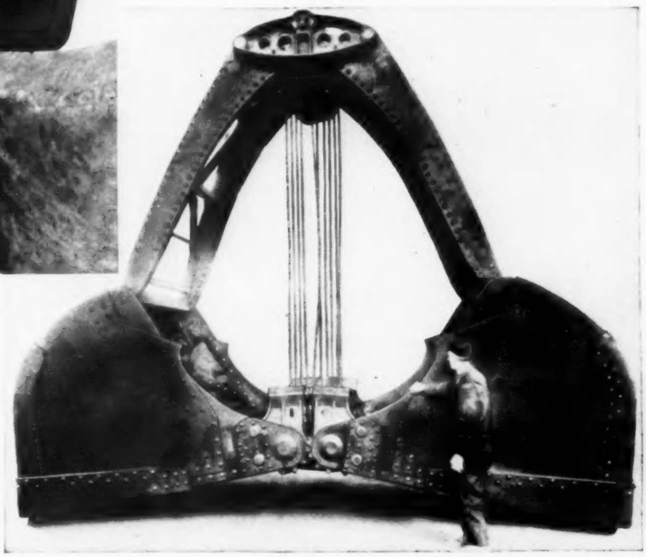


Courtesy of Harnischfeger Corporation

Fig. 5—Top view of a Harnischfeger mill-type overhead crane, showing working elements and lubricator piping to the various bearings, also points of centralized application.

On the other hand, low pour test is of but little consequence where crane operations are carried on under cover and where the buildings are heated. Furthermore, a somewhat heavier

oil will be necessary, especially if the crane operates adjacent to heat appliances, furnaces, etc. In other words, it becomes necessary to give this matter of viscosity careful consideration and operators should remember that where one oil might be ideal for one condition, in another it might be relatively incapable of furnishing lubricating films of the requisite viscosity.



Courtesy of Robins Conveying Belt Company, Mead-Morrison Division.

Fig. 6—Two views of the Mead-Morrison type of grab bucket. Upper left shows the alemite fittings for the enclosed sheaves and main hinge pin. Lower right shows a 12-ton coal digging bucket.

COAL HANDLING EQUIPMENT

In the handling of coal in the medium or larger size plant, the most usual procedure will involve unloading from boats by a hoisting tower, or from railway cars by a track hopper or car dumper. The coal is handled from the unloading unit to the bunker or storage by means of belts or other types of conveyors. Coal can also be handled vertically by means of bucket elevators or skip hoists.

The Skip Hoist

This element is a bucket designed to travel up and down between guides, being hoisted from the loading pit to the discharge level above the storage bunkers by means of cables and a suitable hoist. In the same form the skip hoist is used for handling ashes; likewise for charging materials to the blast furnaces in the steel mill. Essentially, it is an out-of-doors machine and therefore exposed to the elements.

Conveyors

Tram-rail conveyors, and the traveling weighing larries, which are also used for handling of coal within the boiler room, are quite similar to cranes in their design and method of operation. Like the skip hoist, they deliver the materials at periodic intervals, a certain amount of time being necessary for charging, delivery and return of the empty carriers.

Bucket elevators and belt conveyors of either the shuttle or tripper type are widely used for the elevating and distributing of coal in the smaller boiler plant. Where fine coal is involved the screw conveyor is also used to a considerable extent.

Lubrication a Factor

In the operation of any of the above equipment, neglect, and disregard for the importance of lubrication are of chief concern to the lubricating engineer. As a rule, there will be a considerable amount of dust present, and in many cases moving parts will be exposed to a sufficient extent to enable entry of enough abrasive foreign matter to cause considerable wear. This will be especially true on certain apron, belt or chain conveyor roll bearings. For this reason, some builders have made special effort to design their equipment of as nearly oil

and dust-tight a nature as possible, using anti-friction sealed type bearings wherever practicable.

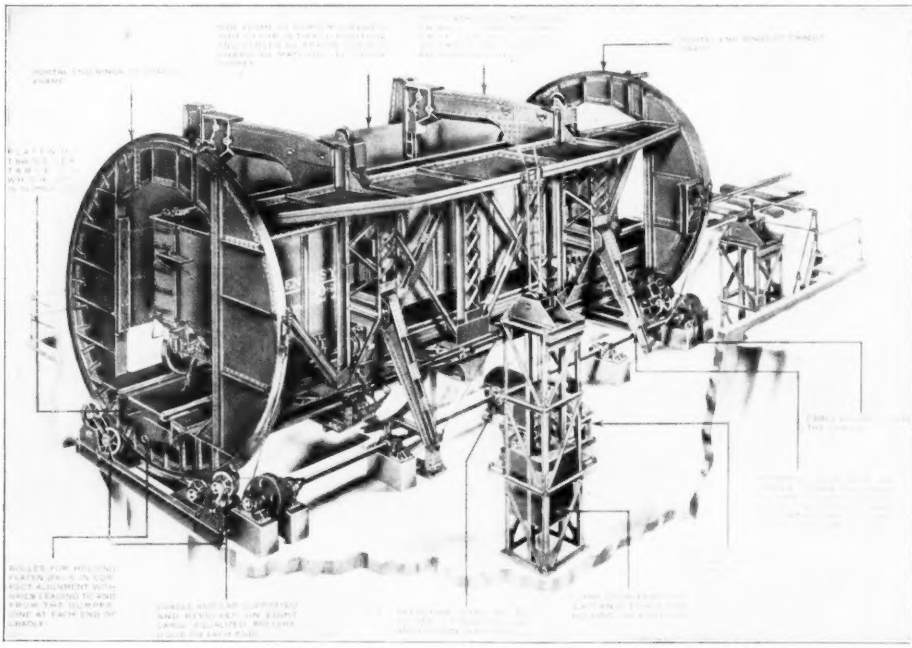
Types of Lubricants

Both grease and oil are acceptable lubricants, according to the design of such parts. The carrier roller, for example, requires oil, a suitable wick being used for distribution. In such a device a straight mineral oil of from 200 to 300 seconds Saybolt viscosity at 100 degrees Fahr., will be satisfactory. In general, such an oil will also be adaptable for the lubrication of the driving motor bearings of either the ring-oiled or anti-friction type, provided the housings will retain oil.

Other types of conveyor rollers will be designed for grease lubrication, being equipped with compression cups or pressure grease fittings. Unless the bearings of such rollers are relatively dust proof, grease will be the more satisfactory lubricant, for it will serve as an effective seal at the rims of the bearings to prevent entry of dirt or dust. The usual procedure in lubricating plain bearing rollers is to screw down the compression cup tops, or continue to force in grease with the pressure gun until there is a slight efflux at the edges of the bearings. Where anti-friction bearings are used, however, the pressure gun must be handled more carefully, for overcharging may affect the seal and cause leakage. For such bearings a specially prepared grease of high stability and low torque characteristics is advisable.

THE ORE BRIDGE AND UNLOADER

Ore is delivered to the steel mill by rail or boat. From here it is handled to storage by the ore bridge or unloader. These devices are flexible, automatic and readily maneuvered with a minimum of labor.



Courtesy of Link-Belt Company

Fig. 7—Details of the Link-Belt Rotary Railroad Car Dumper. Note various references to the working mechanisms and the extent to which these latter are designed and protected in the interest of effective lubrication. This type of car dumper turns the car practically upside down and the discharge is orderly and immediate for all types of open top cars regardless of weather conditions.

The ore bridge, or unloading bridge is very similar to an electric crane, consisting of a frame which is mounted on suitable end trucks or carriages; a runway or track for these latter to travel over; an overhead trolley capable of traveling along the bridge, and a grab bucket or electro-magnet arrangement which operates from the end of the trolley.

In the unloading bridge that part from which the hoisting device operates is often either hinged to form a jib, or arranged so as to telescope within the main structure of the bridge. The object of such construction is to enable operation of the hoisting mechanism between the masts of ships or other obstacles and to facilitate handling down in the holds.

The Automatic Unloader

Another interesting device which is also

widely used for the unloading of ore and coal from the holds of vessels, etc., is the automatic unloader. This device, in turn, comprises a main framework which is mounted on trucks in a similar manner to a crane bridge. These trucks run along trackwork or runways on the wharf, thus enabling movement of the entire frame. On the bridge or framework is mounted a trolley which carries a balanced walking beam. From the outer or hoisting end of this latter is suspended a rigid hoisting leg with a grab bucket at the bottom. Within this leg are located the bucket operating gears, chains and other mechanisms pertinent to horizontal motion. Vertical movement is brought about by operation of the walking beam.

The three-way motion made possible by such construction enables the operator to locate the bucket readily and accurately with respect to the hatch of a vessel, a car or the storage yard; and to manipulate the hoisting media with a maximum of delivery. In other words, after locating the bridge proper, the trolley or hoisting mechanism can be moved along the bridge until the grab bucket or magnet is above the product. It can then be lowered, filled or charged, and raised, to be discharged, after subsequent moving along the bridge according to the location of the point of discharge.

While the electric crane will frequently have the advantage of being located under a housing, with the result that its wearing parts will be more or less protected from the elements, the ore bridge and unloader will, as a rule, be located in the open, along with the car dumper, and other types of such equipment which are used for handling materials in bulk.

Importance of Lubrication

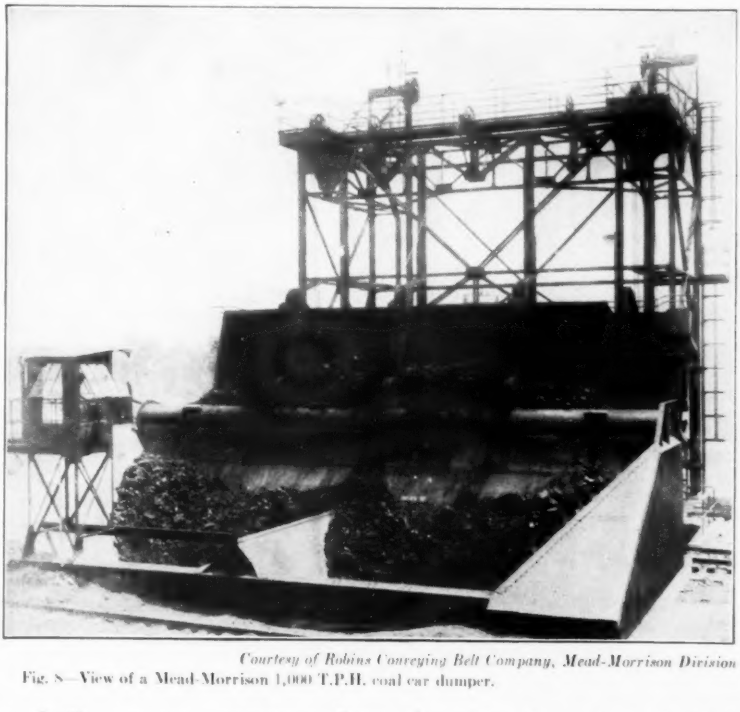
Lubrication of the operating mechanism must therefore be carefully attended to, especially in cold weather. Obviously it becomes a matter of counteracting the effects of detrimental weather conditions by the use of oils, greases and gear and wire rope lubricants which are especially capable of protecting the wearing elements.

Primarily the lubricants should be selected with the utmost care; the management must appreciate that in most cases such products will be called upon to function in the open, subjected to widely varying temperature conditions, and frequently in the presence of rain, snow and ice. Furthermore, many of the wearing elements to be lubricated will be located in, more or less, inaccessible or hazardous parts, where labor will have a tendency to neglect in the interests of personal safety.

In consequence, gear, wire rope and bearing lubrication on such equipment will differ markedly from that involved under the more favorably housed conditions which prevail in many other industries. Then again, there will always be a certain amount of abrasive foreign matter or dust in the air which will have a tendency to contaminate the lubricants and cause scoring and abnormal wear.

It must be borne in mind that on much of such materials handling equipment but few provisions for bath or enclosed lubrication are possible. As a result the maximum of protection is absolutely necessary from a lubricating point of view.

To stop with careful selection would leave the job but half done. Quite as much attention is necessary from the viewpoint of application and handling of oils and greases. For this reason progressive plants, as a rule, will insist on a regular lubrication schedule, in many cases holding individual operators directly respon-



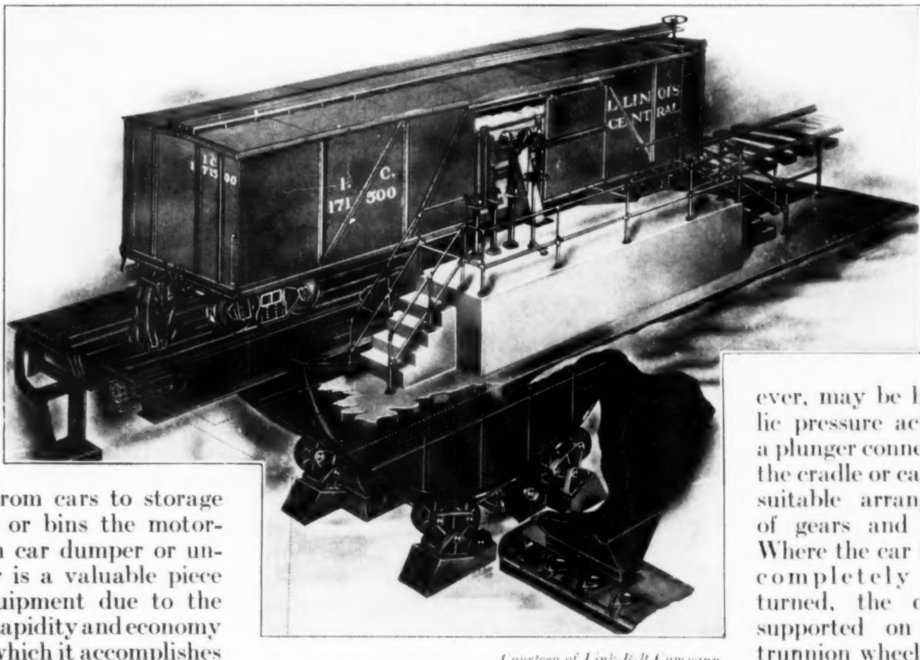
Courtesy of Robins Conveying Belt Company, Mead-Morrison Division

Fig. 8—View of a Mead-Morrison 1,000 T.P.H. coal car dumper.

sible for the efficiency of operation of their respective machinery.

THE CAR DUMPER

In the handling of coal, ore and other products from cars to storage yards or bins the motor-driven car dumper or unloader is a valuable piece of equipment due to the ease, rapidity and economy with which it accomplishes an otherwise dirty job.



Courtesy of Link-Belt Company

Fig. 9—The Link-Belt Grain Car Unloader. In this machine a covered car is tipped both sideways and endways alternately to discharge the contents from each end out of the door. This is another type of mechanism where very careful design has been necessary to enable adequate maintenance of lubrication and to prevent undue wear of the working elements.

The high lift car dumper involves a huge tilting and lifting mechanism which actually tips a car to empty the contents via a chute to the storage yard, bin, hold of a boat or, perhaps, other cars. In general it is quicker and involves less labor than emptying cars via bottom hoppers or by grab bucket methods. It is extensively used for open top cars handling coal at railway terminals, in the loading or coaling of ships, and the delivery of ore to blast furnace storage and mixing bins. The same principle has also been extended to the unloading of closed cars such as are used for transporting grain and sugar cane.

The rotary or revolving unit in turn is designed to simply rotate the car, in order to dump it, without the necessity of lifting to discharge the contents.

In construction, the car dumper involves a structural steel frame, which carries a cradle or cage in which the car is held during the process of unloading. By means of an automatic clamping arrangement the car is held rigidly in the cradle or cage, which tilts it sufficiently to empty the contents, or completely overturns it, according to the design.

Electric power is in general used to operate a car dumper, two motors being necessary, one for operating the clamping mechanism, the other for tilting or rotating the cradle or cage. The actual media for operating the latter, however, may be hydraulic pressure actuating a plunger connected to the cradle or cage, or a suitable arrangement of gears and cables. Where the car is to be completely overturned, the cage is supported on heavy trunnion wheels.

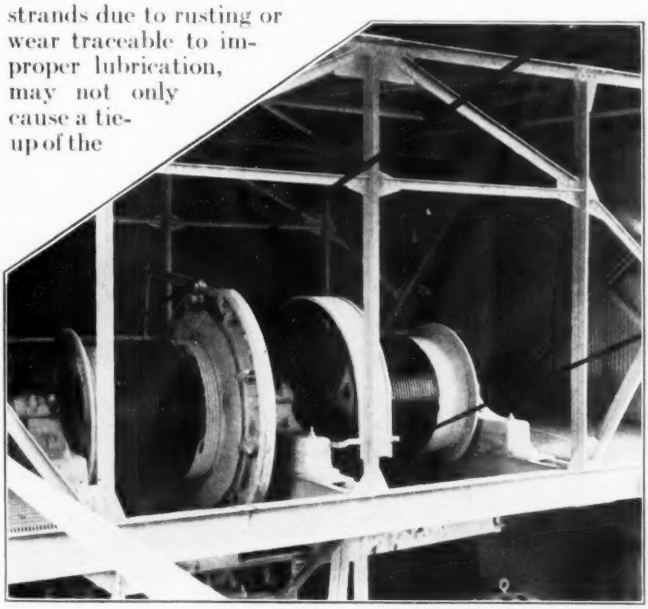
Machinery of this type must be massive, for gross loads of up to, perhaps, 100 tons must be carried with speed, safety and reliability. In consequence, the operating mechanisms are designed with the utmost care. The necessarily large gears, heavy bearings and other equipment which this involves place an unusual responsibility upon the operator after such a machine is installed, due to the exacting lubricating requirements.

Such equipment can be kept ready for continuous and efficient operation by proper lubrication. The loads involved in handling a 70- or 90-ton gondola car are enormous and impose a duty on bearings and gear teeth, which in other industries would be frequently considered prohibitive. To meet these conditions the lubricants employed must be so refined as to develop a lubricating film capable of resisting any squeezing out action. They must also be of such a nature as to be able to flow readily under low temperature conditions. Car dumpers are exposed to the elements, located very frequently on the coast or Great Lakes where cold, wind, rain, hail, snow and ice must be met and counteracted. Hence the caution regarding

fluidity where selecting lubricating oils, greases and gear lubricants. Congealment may readily prove damaging to many of the parts, and necessitate costly repairs.

WIRE ROPE PROTECTION

Wire rope must be carefully protected in cold weather for as temperatures are reduced many lubricants will tend to chip or crack. This will lead to exposure of more or less of the rope surface and enable moisture to penetrate and cause rusting, corrosion and wear. Obviously the purpose should be to prevent such a condition by careful choice of a type of lubricant which has been especially prepared to possess the necessary cohesion and adhesion at low temperatures. The ultimate efficiency of any materials hoisting operation is largely dependent upon the condition of the cables or wire ropes which carry the loads. Wire rope lubrication is therefore one of the most important factors in any such plant. The primary purpose of lubrication is to prevent rusting of the strands and to retard wear by reducing friction as far as possible. Obviously a rope with one or two broken strands due to rusting or wear traceable to improper lubrication, may not only cause a tie-up of the entire machine if such strands interfere with the operation of sheaves, or other companion cables, but may also present a distinct hazard. Any wire rope in such condition is just that much weaker and less capable of handling the imposed loads.



Courtesy of Hazard Wire Rope Co., Inc., and American Chain & Cable Co., Inc.

Fig. 10—An interesting view showing how a well lubricated wire rope should appear. In the opinion of the manufacturer prompt lubrication of a new rope is an important matter in order that the internal lubricant will be restrained from working its way out to the rope surfaces. Under cold weather operation, frequent application of a comparatively light-bodied lubricant is considered more effective than the use of a heavier material which might become so hard as to be unable to perform its intended function.

Friction and wear are continually occurring between the strands of any wire rope. There is also a tendency to squeeze out any contained lubricant, especially when the ropes pass over sheaves or around drums. The renewal of this product is, therefore, an absolute necessity regardless of how effectively the core may have been saturated with lubricant by the manufacturers.

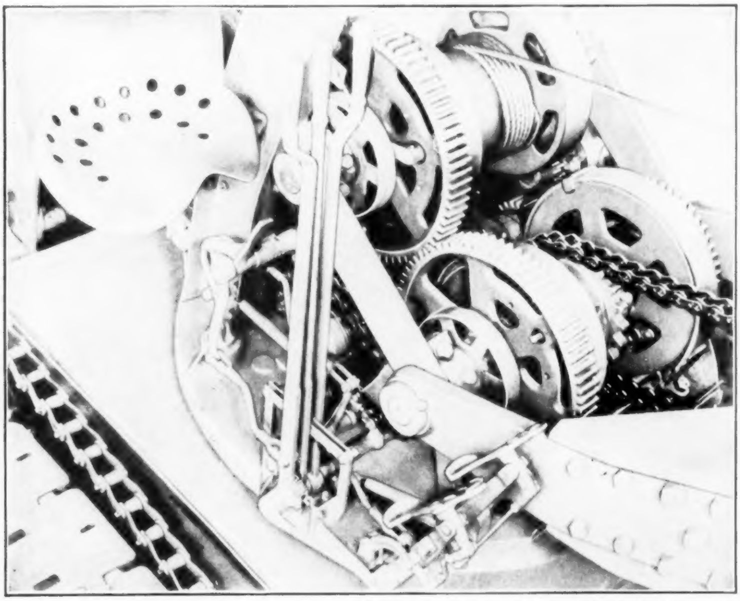
There is but little difference between friction as it occurs between the strands of a wire rope and friction between a bearing and shaft. Overheating and abnormal wear will practically always result, to reduce the load-carrying capacity and increase the amount of power consumed in operation. This can only be overcome by effective lubrication, brought about by the proper application of a suitably prepared wire rope compound, which will be capable of not only penetrating to the innermost strands and core of the rope, but also sufficiently adhesive and viscous to resist being prematurely squeezed out or washed off by the elements.

Such a lubricant must also resist any tendency to cake, gum or ball up, especially if contaminated with an excess of dust, dirt or metallic particles. Furthermore, it must not thin down to an excess when exposed to high temperatures. This, of course, directly involves the viscosity or relative fluidity of the product. In fact, viscosity of such products is the essential characteristic involved in purchasing. It should not, however, be assumed as being the chief guide as to the actual suitability of a wire rope lubricant. In this regard the ability of the latter to function, penetrate and stick under actual operating conditions, is of outstanding importance.

According to the operating temperatures that may be involved, and the possibility of the presence of an excess of water, the viscosity of a wire rope lubricant should range from 500 to 1000 seconds Saybolt at 210 degrees Fahr. In service adjacent to ovens, furnaces or open hearths, etc., where there might be possibility of such a product thinning down to the extent of dripping off to perhaps result in lack of lubrication, it will be advisable to regard the maximum temperature prevailing as the criterion in selecting the lubricant. The same holds true for continued cold weather operation. Here, in service adjacent to the Great Lakes, in Canada or the Northwest, it will normally be advisable to use a lubricant of

around 500 seconds viscosity in the interest of ease of application and to assure of adequate ductility and resistance to cracking or chipping.

Wire rope lubricants to meet the aforesaid requirements should, in general, be straight mineral petroleum products, devoid of fillers or thickening medium. In other words, whatever the viscosity, it should be an inherent property of the lubricant, not an artificial characteristic which might be affected by temperature change or contamination.



Courtesy of The Austin-Western Road Machinery Co.

Fig. 11—Certain of the working mechanisms of an Austin-Western shovel turntable showing relation of gears, wire rope, chains and bearings to one another. Inasmuch as some of these mechanisms may be exposed to the elements, and to more or less dust and dirt, their lubricants should be of such a nature as to not only adhere tenaciously to the contact surfaces but likewise to resist contamination as far as possible.

For this reason greases or soap-thickened mineral oils are relatively unsuited to wire rope lubrication. To attain the requisite body a comparatively high percentage of soap would be necessary. Soap, of course, serves as the carrying medium for the oil. It has relatively no lubricating value; as a result, this property in the resultant product is decreased to a marked extent. Furthermore, the adhesive characteristic may be too low. In consequence, such products will not, in general, meet the requirements of wire rope lubrication especially under conditions of exposure or wide temperature change.

Application of Wire Rope Lubricants

In cold weather service, heavy wire rope lubricants can best be applied in heated condition. This will reduce the viscosity temporarily and facilitate handling in some form of automatic lubricator. To merely attempt to daub or paint a rope with such a product at normal temperatures would be relatively difficult. Even though the surface might be more or less coated, the possibility of penetration occurring to any extent would be remote. For this reason some authorities prefer to use a lighter bodied lubricant and to apply it more frequently.

Penetration is the secret of proper wire rope lubrication. Where it is effectively brought about, the wear between the internal strands will be markedly retarded. It is this latter which is so definitely related to rope life. Furthermore, if adequate penetration is attained, protection of the external surfaces will be automatically assured.

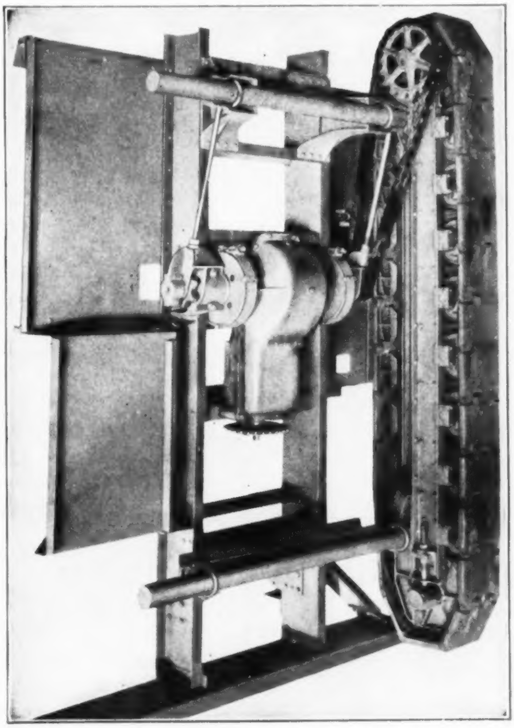
Exposed wire rope such as found on steel mill cranes, mine hoists and around the ore docks can be effectively lubricated by using a form of split box through which the rope can be run. Such a box can readily be built in the average plant, with suitable provision for rendering it sufficiently tight to prevent the lubricant from leaking out, even when reduced in viscosity by heating. The slow passage of the rope through such a bath of heated compound will insure that not only will the surface be coated, but also that the requisite penetration takes place to the inner strands. Further working of the rope over the sheaves before the lubricant has time to cool entirely will tend to aid in bringing about the maximum of penetration even to the extent of re-saturation of the core.

GEAR DRIVES

A study of gear lubrication in connection with cold weather operation of hoisting equipment will be especially advisable wherever gears must operate exposed to the elements or in an atmosphere of dust and dirt. There are certain definite properties which a gear lubricant should possess if it is to function effectively.

A straight mineral lubricant is usually best suited to the types of gears employed on materials hoisting machinery. Where the gears are to be lubricated independent of their bearings the viscosity of such a lubricant should be relatively high. In other words, it should vary

from perhaps 200 seconds to 5000 seconds Saybolt at 210 degrees Fahr. This is a wide range, but we are confronted with a wide range of



Courtesy of Chain Belt Company

Fig. 12—Under body of a Chain Belt tractor element showing method of drive and type of housing provided to protect lubrication.

operating conditions, and constructional requirements. Properly classified in accordance with the types of gears involved the viscosity range will fall within reasonable limits. Where the bearings must be lubricated simultaneously, the lower range of the above viscosities will prevail.

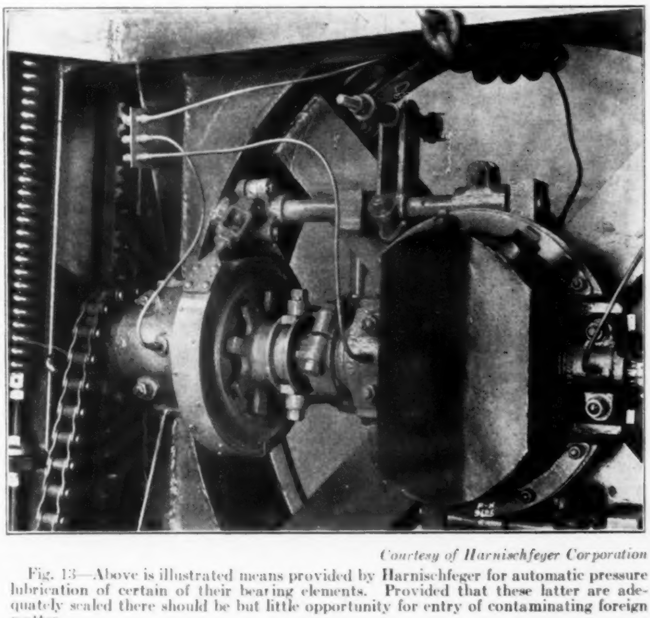
Methods of Gear Lubrication

Industrial gears must be lubricated in accordance with the type of service involved, the location, and the function of the units. As a general rule gear lubrication can be divided into five classifications according to the manner in which it can be most effectively performed.

Where an oil-tight casing or housing is employed, the gears can frequently be lubricated apart from their shaft bearings. This is the most ideal condition for it makes possible the use of a lubricant of just the right viscosity to withstand the prevailing pressures and temperatures. As a rule, bath, pressure or splash lubrication will be applicable. Where the former is used a somewhat heavier product will be necessary than where the lubricant is forced or splashed onto the teeth under a certain amount of pressure. With a force feed system lighter lubricants are usually delivered to the teeth just before they pass into mesh, through a suitable circulating system.

In many cases, however, the gears will be so enclosed, but in addition their bearings will have to be lubricated by the same lubricant. Here a compromise must be made, just as in the case of the reduction geared turbine. In other words, using a product sufficiently fluid to serve the bearings and yet viscous and adhesive enough to maintain a satisfactory film on the gear teeth. Under such conditions, a viscosity range of from 60 to 200 seconds Saybolt at 210 degrees Fahr., will serve the purpose. Worm reduction gears are typical examples of the above. Here ball or roller bearings frequently present another point for consideration, wherever they are contained within the case. Naturally as light a lubricant as possible should be used under such conditions according to operating speed and the probable temperature rise.

All gears, however, are not encased. Frequently some will be entirely exposed, as are the gears on certain hoisting and excavating machinery. Here the lubricant usually must be applied by hand, requiring a highly viscous product. As a rule a viscosity of from 1000 to



Courtesy of Harnischfeger Corporation

Fig. 13—Above is illustrated means provided by Harnischfeger for automatic pressure lubrication of certain of their bearing elements. Provided that these latter are adequately sealed there should be but little opportunity for entry of contaminating foreign matter.

5000 seconds Saybolt at 210 degrees Fahr., will best resist the effects of weather, centrifugal force, and the usual dusty or dirty conditions which may be involved. Too, it will remain the longest on the teeth, thereby requiring but relatively infrequent renewals. On the other hand it is the more difficult to apply due to the necessity for pre-heating.

In other instances, exposed gears will operate with their lower portion partially enclosed in an oil tight pan which will permit of bath lubrication. This affords relatively automatic lubrication, though, of course, it is necessary to keep the level of the lubricant as low as possible to prevent splashing or throwing, especially if the gears are run at higher speed.

Greatest economy will result where the lowermost teeth of the main gear just dip into the lubricant, provided, of course, that the latter is of the requisite viscosity and tenacity to adhere sufficiently to these teeth and later to be distributed to the teeth of such other gears as may be involved in the train. Under slower speed conditions a lubricant of about 200 seconds Saybolt viscosity will meet these requirements. Where speeds are higher, however, or temperatures excessive, it may be advisable to use a heavier product of about 1000 seconds Saybolt viscosity at 210 degrees Fahr.

The final classification may be taken as covering those entirely exposed gear sets where dirt and other foreign matter may preclude effective lubrication, however carefully the problem be analyzed. Gears on certain types of coal and ore handling machinery are a good example of such a condition. Here the best one can do is seek for a lubricant which will stick, and yet not be so viscous as to ball up when contaminated with dust or dirt, etc. A straight mineral product of from 1000 to 2000 seconds Saybolt viscosity at 210 degrees Fahr., will, as a rule, give the most satisfactory results. Frequent re-lubrication is advisable under such conditions.

GREASE LUBRICATION

In view of the necessity for a means of lubrication that will function relatively automatically and be capable of withstanding the hard knocks so prevalent in materials handling service, grease lubrication is extensively employed on many of the shafts and sheave bearings of the electric crane, unloader and other equipment of this nature. In many cases such bearings are located in dangerous and inaccessible positions, where regular oiling, or the filling of oil cups, etc., would be comparatively difficult or even impossible without complete shut-down.

Grease lubrication by means of the pressure gun or the hand or spring regulated compression cup is therefore regarded by many engineers as an effective means of keeping such bearings operating with a minimum of care and the least amount of danger to the operators. Where hand regulated compression cups are involved it requires but a moment for the operator to reach in and screw down the regulator. Usually this can be done with but little danger while the machine is in motion. On more inaccessible parts, however, automatic lubrication from a central point of application via a pressure gun will even eliminate this necessity, requiring attention only when refilling or cleaning is essential.

Wherever lubricators might become clogged, especially when functioning in an atmosphere of dust and dirt, it is advisable to clean them out and flush the bearings regularly to prevent accumulations of foreign matter therein. This, of course, can be carried out at the regular inspection periods, with perfect safety, when the machine is shut down. A properly constructed grease cup or pressure gun fitting, however, should effectively prevent the entry of an excess of dust and dirt via the oil ways, and the film of grease at the outer edge of the bearing should keep foreign matter from penetrating at this point.

To meet these conditions the selection of suitable greases must be given careful thought. However adaptable may be the means of lubrication, it cannot be depended upon if greases unsuited to usage therein are used. The essential factors requiring consideration in this regard are solubility and consistency.

Inasmuch as such lubricants must frequently function under moisture conditions, they must of course be compounded from the highest grades of mineral oils and water-resistant soaps. The use of any ingredients which might be readily soluble in water at normal temperatures might easily lead to imperfect lubrication due to impairment of the body of the grease and premature flow of the lubricating oil through the bearings. The soap constituent is the carrier for the oil, and as such must retain it in a perfect state of mixture, to be capable of feeding it to the bearings according to their requirements. Therefore this soap must be immune to reaction with water, chemicals, fumes or vapors of any description.

The requisite consistency of grease to use will in turn be dependent upon the type and size of the bearings, the pressure involved and the variety of lubricator used. Compression cups will, in general, function best on relatively solid greases. The pressure gun, however, will require softer products of the type which would lend themselves to subsequent pumping action

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